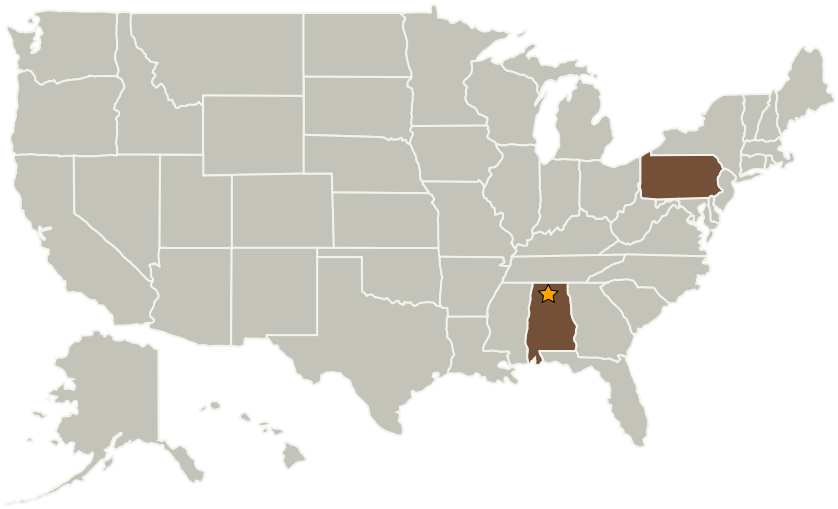
Modeling Unsteady Cavitation Effects and Dynamic Loads in Cryogenic Systems, Phase I

Completed Technology Project (2004 - 2004)

Project Introduction

There currently are no analytical or CFD tools that can reliably predict unsteady cavitation dynamics in liquid rocket cryogenic systems. Analysis of cavitating cryogenic systems presents a challenge, and is poorly understood, because the phase change process couples with the temperature fluctuations in the fluid. In particular when large scale flow unsteadiness is present at low-flow, off-design conditions, this coupling can lead to significant enhancement of vaporization and possibly lead to cavitation instabilities. These large amplitude, dynamic loads can interact with other system components and cause severe damage. The innovation proposed here is the development of an unsteady numerical framework that can predict amplitudes and frequencies of dynamic pressure loads in cryogenic fluids. This innovation will address the inclusion of advanced unsteady cavitation models, validation for pressure fluctuations in cryogenic fluids, and development of unsteady boundary conditions for coupling the turbopump to other system components. An experimental program will be set up in the Phase II effort to obtain unsteady flow data for code validation. The resulting product, a specialized version of the multi-element unstructured CRUNCH CFD code, will be a well-validated and reliable analysis tool that can be used to predict unsteady, off-design performance of liquid rocket turbopumps.

Primary U.S. Work Locations and Key Partners



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

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Organizations Performing Work	Role	Type	Location
★Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama
CRAFT Tech - Combustion Research and Flow Technology	Supporting Organization	Industry	Pipersville, Pennsylvania

Primary U.S. Work Locations	
Alabama	Pennsylvania

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Ashvin Hosangadi

Technology Areas

Primary:

- TX14 Thermal Management Systems
  - TX14.1 Cryogenic Systems
    - TX14.1.5 Cryogenic Analysis, Safety & Properties